GP-304503

HYDROTAPPING POWER UNIT

TECHNICAL FIELD

This invention relates to a power unit for powering a hole-piercing/extruding/thread-forming tool and more particularly to a power unit for powering such a tool in a prescribed manner so as to form a relatively deep threaded hole in a hydroformed part while the part remains in the hydroforming dies.

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BACKGROUND OF THE INVENTION

In U.S. Patent Application Serial No. 10/690,100 filed October 21, 2003 and entitled "METHOD AND APPARATUS FOR FORMING A THREADED HOLE IN A HYDROFORMED PART" and assigned to the assignee of this invention, there is disclosed a tool for piercing a hole in a hydroformed part and then forming a thread in the hole while the part remains in the hydroforming dies following its hydroforming. Wherein the tool which is referred to as a hydrotapping tool (1) first pierces the hole in a tool advancing tool operation while the hydroforming pressure is maintained, (2) then extrudes the wall about the hole in a continued tool advancing operation to thereby deepen the hole, (3) then sizes the deepened hole in a continued tool advancing operation, (4) then in a turning and advancing tool operation forms a thread in the hole in a metal displacing operation, and (5) then is retracted from the threaded hole while being rotated in the opposite direction in order to release the tool from the threaded hole. And wherein in the thread forming operation, the tool must be fed at a feed rate equal to that of the thread-forming portion of the tool and also at this same feed rate but in the opposite direction in order to retract the tool from the threaded hole without wiping out the formed thread.

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While a power arrangement suitably adapted to powering the tool as disclosed in the above-mentioned U.S Patent Application Serial No.

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10/690,100 would be satisfactory in many cases, there remains a need for a rugged and highly reliable power unit for powering such a tool in meeting the demands of high volume production. Such as for example the hydroformed part for mass-produced motor vehicles. Wherein one or more threaded holes are required in the hydroformed part and each threaded hole must be accurately located and the thread formed therein made strong and precise and all without producing metal cuttings that could enter the part and contaminate the hydroforming apparatus. Such as would be the case with a drilling operation followed by an extruding operation and then a threading operation using a thread cutting tap in order to form the required threaded hole.

SUMMARY OF THE INVENTION

The present invention meets the goals of sufficiently and efficiently powering such a hydroforming tap with a hydrotapping power unit comprising a powered drive mechanism operable to (1) hold a hole-piecing/extruding/thread-forming tool in a home holding position adjacent a part while the latter is being hydroformed in a die cavity, (2) then advance the tool to pierce a hole in a hydroformed part while the part remains in the die cavity and under pressure and then continue to advance the tool to inwardly extrude and size the part about the hole, (3) then further advance while also rotating the tool at a feed rate equal to the thread-forming pitch of the tool to thereby form a thread in the pierced hole, and (4) finally retract while also rotating the tool but in the reverse direction and at the same feed rate to release the tool from the threaded hole. The powered mechanism for performing these operations includes a linearly moveable shaft for holding the tool, a powered device for rotating the shaft, another powered device connected to the shaft by a lead screw connection having a thread pitch equal to that of a thread-forming portion of the tool, and a third powered device that is adapted to intercept and prevent shock loading on the tool from the piercing operation and thereby on the shaft from reaching the lead screw connection.

the lower die 10A that extends through the die cavity surface and is centered on where the threaded hole is required in the part.

The tool 16 is like the tool embodiment disclosed in Figure 11 of the aforementioned U.S. Patent application Serial No. 10/690,100 that is hereby incorporated by reference. The tool 16 is referred to therein as a hydrotapping tool and accordingly, the power unit 18 is referred to herein as a hydrotapping power unit as it is specially adapted to power such a tool. And it will also be understood that while only one of the tool embodiments is shown in the accompanying drawings, the other tool embodiments disclosed in the aforementioned U.S Patent Application Serial No. 10/690,100 have the same power requirements and can also be powered by the power unit 18 in a like manner to form a threaded hole in a hydroformed part while the part remains in the hydroforming dies.

In order to understand and fully appreciate the contributions of the hydrotapping power unit 18, it is necessary to understand the power requirements of the hydrotapping tool 16 which will now be described. The tool 16 is basically a one-piece tool having a hole-piercing end portion 20 at one end, an extruding portion 22 adjoining the end portion, a hole-sizing portion 24 adjoining the extruding portion, a relief portion 26 adjoining the hole-sizing portion, a thread-forming portion 28 adjoining the relief portion, and a tool-fastening portion 30 with a square cross-section at the other end of the tool.

The tool 16 must be initially positioned and held in the tool guide bushing 19 in the lower die 10A so that its piercing end is flush or at least only slightly retracted with respect to the immediately surrounding die cavity surface during the hydroforming of the part and is adapted on advancement of the tool in this bore to pierce and form a hole in the part without producing a separated slug and while the hydroforming pressure remains in the part to support this operation. The extruding portion 22 of the tool is in contrast adapted on continued tool advancement to enter the pierced hole and

expanded and substantially deepened hole in the part prior to the hole-sizing tool portion 24 entering the hole to size it to the proper diameter for thread forming as distinguished from thread cutting.

The piercing end portion 20 of the tool at the end of the piercing operation produces one or more appendages 148 that remain integral with the inner edge of the neck portion 146. Wherein the number of such appendages depends on the shape of the piercing end of the tool as disclosed in the aforementioned U.S. Patent Application Serial No. 10/690,100. With only one such appendage as shown occurring in this example as a result of using the exemplary tool 16. And it will also be understood that the configurations of the respective hole piercing end portion 20 and extruding portion 22 of the tool 16 are determined dimensional wise for a particular application so as to pierce and extrude the wall of the part inwardly to the extent necessary to form the wall of the hole in the neck portion 146 with a depth or axial extent that allows the formation therein of the number of threads required to adequately secure a particular screw or bolt or male threaded part.

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When the wall of the part is initially pierced in the hydropiercing operation by the piercing end portion 20 of the tool, there will typically occur a sudden drop in the hydroforming pressure within the part following the shock load delivered to the tool. This pressure drop may for example be 80% of the forming pressure but it has been found that the remaining 20% is sufficient to force the hydroforming fluid to advantageously both flush and lubricate the extruding tool portion 22 to thus facilitate its extruding operation as it proceeds to advance into the pierced hole and inwardly extrude the wall of the part about the pierced hole.

At the end of this phase of tool operation which has occurred without tool rotation and with the relief portion 26 having entered the hole, the primary piston 40 remains in its advanced position and the secondary piston 52 is then retracted as shown in Figure 4 by exhausting the chamber 62A and supplying hydraulic fluid under pressure to the chamber 62B as